Racial Differences in the Use of Invasive Cardiovascular Procedures: Review of the Literature and Prescription for Future Research

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Purpose: **The cause of racial disparities in the use of invasive cardiac procedures remains unclear. To summarize, evaluate, and clarify gaps in the literature, studies examining racial differences in cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA), and coronary artery bypass grafting (CABG) were reviewed.**

Data Sources: **MEDLINE search for English-language articles published from 1966 to May 2000.**

Study Selection: **Empirical studies of adults.**

Data Extraction: **The odds ratios for procedure use by race were examined for each study; cohorts and covariates were also documented.**

Data Synthesis: **Literature was classified as one of three groups on the basis of study design. For the first group, which used administrative data, odds ratios (ORs) for African-American patients compared with white patients ranged from 0.41 to 0.94 for cardiac catheterization, from 0.32 to 0.80 for PTCA, and from 0.23 to 0.68 for CABG. Procedure rates were also lower for Hispanic and Asian patients. In the second group, which used detailed clinical data, African-American patients remained disproportionately less likely to receive cardiac catheterization (OR, 0.03 to 0.85), PTCA (OR, 0.20 to 0.87), and CABG (OR, 0.22 to 0.68). A few studies noted that Hispanic and Asian patients were also disproportionately less likely to receive such procedures. The third group used survey methods but found conflicting results regarding patient refusals as a source of racial variation. Less-educated patients and patients who were not as experienced with the procedure were more likely to decline PTCA. Physician bias was also associated with racial variation in recommendations for treatment.**

Conclusions: **Racial differences in invasive cardiac procedure use were found even after adjustment for disease severity. Future studies should comprehensively and simultaneously examine the full range of patient, physician, and health care system variables related to racial differences in the provision of invasive cardiac procedures.**

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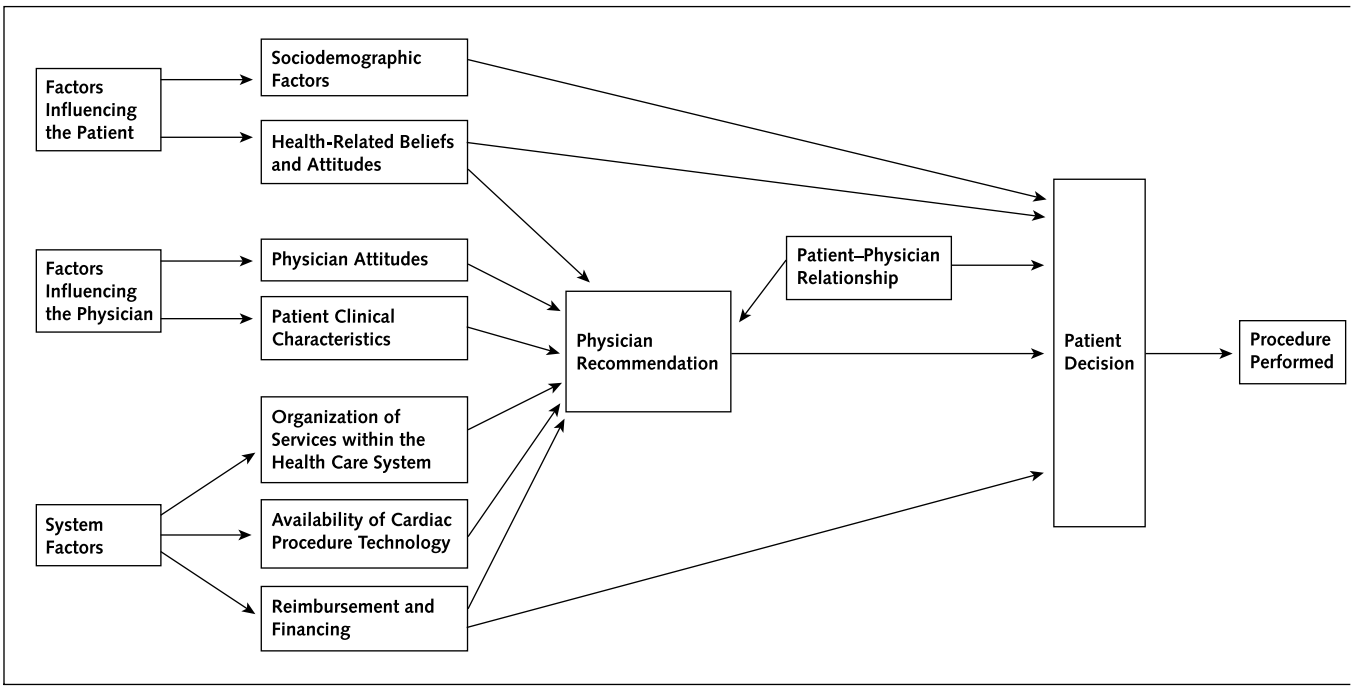
Racial differences in health care outcomes have been widely documented in the United States (1, 2). Because of increasing concern about this problem, the Clinton administration spearheaded the Initiative to Eliminate Racial and Ethnic Disparities in Health in six clinical areas, including cardiovascular disease, by the year 2010 (3).

To target interventions that will help achieve the Initiative's goals, the genesis of racial disparities in health care utilization must be understood. In this paper, we focus on coronary heart disease, the leading cause of death in the United States (4, 5) and the focus of many previous studies of racial variations in health care. Invasive cardiovascular procedures, such as coronary catheterization (also called angiography), percutaneous transluminal coronary angioplasty (PTCA), and coronary artery bypass grafting (CABG), improve diagnostic precision (6), delay death, and relieve symptoms for many patients with coronary heart disease (7–10). However, numerous studies have shown that African-American persons and members of other minority groups are less likely to receive these procedures in various health care settings.

The reasons for this disparity have not been conclusively identified (11, 12), although possible explanations include racial differences in clinical indications for procedures, access to care, patient preferences, and provider bias. The **Figure** depicts our conceptual model for factors associated with racial variation in use of cardiovascular procedures. Patient characteristics that probably influence decision making include sociodemographic variables (race, age, income, education, marital status, and amount or type of health insurance), clinical characteristics (disease burden and disease severity), and health-related beliefs and attitudes. Provider characteristics, including practice specialty, attitudes, or bias about patients, may also influence decision making, as may aspects of the patient–provider relationship (for example, communication and trust). Finally, characteristics of the health care system in which treatment decisions are made (availability of cardiac procedure technology, or-

Figure. **Overall conceptual model.**



ganization of services within the health care system, and local practice patterns), as well as reimbursement and financing issues, must be considered. Most of these variables have been included separately in at least one previous study, but as we will argue, comprehensive studies that simultaneously address this broad range of factors are needed.

The definition (13–16) and measurement of race in health services research are inconsistent. Because we analyzed previously published data, we relied on the original authors' definition of race. Racial and ethnic designations are also strongly confounded by social class, economic deprivation, and education level. To the extent that African-American persons have higher unemployment, less insurance coverage, less education, or lower incomes than white persons (17, 18), their ability to pay for cardiac procedures is decreased and may influence clinicians' recommendations or patients' acceptance of such recommendations (19). Furthermore, access to regular medical care may enable patients to receive early diagnosis and treatment of coronary heart disease that otherwise might go undetected until late in the disease process. Thus, it is important to consider factors correlated with race, as well as race itself, when trying to understand racial variations in health care utilization. The purpose of this paper is to review the literature examining racial differences in the use of invasive cardiac procedures, to identify gaps in previous research, and to describe promising directions for future research.

METHODS

We searched MEDLINE from 1966 to May 2000 for all studies with subject headings related to cardiac catheterization, PTCA, and CABG. We used the search terms *coronary angiography*; *coronary arteriography*; *heart catheterization*; *angioplasty, transluminal, percutaneous coronary*; *coronary artery bypass*; and *myocardial revascularization*. We searched for studies that included the keywords *cardiac surgical procedures*; *cardiovascular procedures*; *invasive cardiac procedures*; or *surgical procedures, operative* [*statistics & numerical data, utilization*]. We included studies with the keywords *myocardial ischemia* [*diagnosis, ethnology, surgery, therapy, or etiology*]; *myocardial infarction* [*diagnosis, ethnology, surgery, therapy, or etiology*]; *coronary disease* [*radiography, surgery, therapy*]; *coronary vessels* [*radiography, surgery*]; and *angina, unstable* [*surgery, therapy*]. Next, to identify studies that also

focused on race, we included the following search terms: *Blacks*, *African Americans*, *Hispanic*, *Hispanic Americans*, *Latinos*, *Asian*, *Asian Americans*, *ethnic groups*, *racial stocks*, *Caucasoid race*, or *Whites*. We also included studies with the keywords *ethnicity*, *racial differences*, or *race*. After we combined these searches, one of the authors reviewed the citation titles. Studies of children, review articles, letters or other nonempirical reports, and papers not published in English were eliminated. Many other studies were also eliminated because they reported laboratory research not specifically focused on use of invasive procedures or were otherwise not relevant (for example, studies of sex differences in use of cardiac procedures that controlled for race). We identified additional studies after reviewing the reference lists of selected papers; we also verified that the keywords we used in our search were consistent with those used in the published articles. The final list of citations included studies that documented actual procedures as well as physician recommendations.

When published results included the odds of particular procedures for white persons compared with persons from minority groups, we recalculated odds ratios to reflect the odds for minority groups compared with white persons. If study results did not include odds ratios or confidence intervals, we calculated them on the basis of the information given, when possible.

RESULTS

Of 637 studies identified, 61 met our criteria. We divided studies into three groups on the basis of the type of data used. The first group used administrative data, the second group used clinical data or information on patient characteristics, and the third group used survey data. We discuss each group separately by describing the types of variables assessed in each study, using the categories presented in the **Figure**.

Administrative Data Studies

We identified 27 administrative data studies. Of these, 26 used administrative databases (for example, claims or discharge data, including diagnostic or procedure codes, such as those used in the International Classification of Diseases, Ninth Revision, Clinical Modification [20]), and 1 used data from medical records without controlling for disease severity. The **Table** shows that study samples included patients cared for in a particular state or other defined geographic area (21–28); Medicare enrollees (29–36); random samples of patients hospitalized in nonfederal hospitals in the National Hospital Discharge Survey (37–40); and patients cared for in specific health care systems, such as the Department of Veterans Affairs (41–45) or individual clinics (46). Because clinical data were limited, these studies controlled for disease severity primarily by using counts of secondary diagnoses (for example, the Charlson index [75]) or by selecting cohorts of patients with the same discharge diagnosis (such as acute myocardial infarction) (23, 28, 30, 33, 36, 39, 41, 44).

All of these studies found statistically significant racial differences in some procedure rates. The **Table** includes descriptive information, odds ratios, and confidence intervals, where available, from referenced studies. Among studies that detected statistically significant differences, the odds ratios for African-American patients compared with white patients ranged from 0.41 (36) to 0.94 (36) for coronary angiography, 0.32 (29) to 0.80 (24) for PTCA, and 0.23 (40) to 0.68 (24) for CABG.

Carlisle and colleagues (25), in contrast, found no racial differences in use of cardiac procedures among the privately insured persons studied. However, they found some differences among patients who were members of a health maintenance organization or had Medicaid, Medicare, or no insurance coverage. This suggests that other sociodemographic characteristics of privately insured patients, such as education and social class, may be associated with the lack of racial differences in procedure use. Wenneker and Epstein (21) found no differences in PTCA rates, but their study was conducted when PTCA was relatively new and the number of PTCA cases included was small.

Five of the six studies examining minority groups other than African-American persons also documented disproportionately less use of some cardiac procedures. In one study, Hispanic persons were less likely than white persons to receive coronary angiography and CABG but not PTCA; however, Asian persons and white persons did not differ (24). Another study found that Hispanic and Asian persons were less likely than white persons to receive PTCA and that Hispanic persons were also less likely to receive CABG (26). Among health maintenance organization enrollees, Medicare enrollees, and uninsured persons, Hispanic persons were

Table. **Administrative Data and Clinical Studies on Racial Differences in Provision of Invasive Cardiac Procedures***

Study (Reference), Year	Racial Groups Studied	Cohort Definition	Findings†				Variables Assessed‡			
			CC	PTCA	CABG	Any	Clinical Characteristics	Reimbursement or Financing	Organization of Services in System	Availability of Cardiac Procedure Technology
Administrative data studies										
Wenneker and Epstein (21), 1989	W, AA	All patients in MA discharged with circulatory diseases and chest pain, 1985	OR, 0.78 (0.64–0.93)	OR, 0.59 (0.39–1.25)	OR, 0.53 (0.36–0.77)		Yes	Yes	No	No
Hannan et al. (22), 1991	W, AA	Patients hospitalized with CAD in NY State, January–June 1987	OR, 0.80 (0.48–0.74)	OR, 0.59 (0.74–0.87)	OR, 0.49 (0.41–0.57)		Yes	Yes	No	No
Blustein et al. (23), 1995	W, AA, H	Non-Medicare patients in California discharged with AMI, 1991				Minorities: OR, 0.56	Yes	Yes	Yes	Yes
Carlisle et al. (24), 1995	W, AA, H, A	LA County residents discharged from CA hospitals with IHD-related primary diagnosis, 1986–1988	H: OR, 0.90 (0.85–0.95) AA: OR, 0.94 (0.89–1.00) A: OR, 1.03 (0.95–0.11)	H: OR, 0.99 (0.90–1.09) AA: OR, 0.80 (0.72–0.88) A: OR, 0.89 (0.79–1.01)	H: OR, 0.87 (0.79–0.94) AA: OR, 0.62 (0.56–0.69) A: OR, 1.03 (0.92–1.15)		No	No	No	No
Carlisle et al. (25), 1997	W, AA, H, A	Patients discharged from hospitals in LA County, CA, with a diagnosis of AMI, unstable angina, angina pectoris, chronic myocardial ischemia, and chest pain, 1986–1988	Private insurance AA: OR, 0.99 (0.85–1.14) H: OR, 0.44 (0.82–1.07) A: OR, 1.01 (0.84–1.22) HMO AA: OR, 0.80 (0.67–0.96) H: OR, 0.78 (0.64–0.96) A: OR, 0.80 (0.61–1.05) Medicaid AA: OR, 0.84 (0.67–1.06) H: OR, 0.86 (0.71–1.05) A: OR, 1.38 (1.07–1.78) Medicare AA: OR, 0.91 (0.82–1.01) H: OR, 0.88 (0.79–0.98) A: OR, 0.94 (0.78–1.14) No insurance AA: OR, 0.51 (0.36–0.71) H: OR, 0.50 (0.38–0.66) A: OR, 0.82 (0.57–1.19)	Private insurance AA: OR, 0.99 (0.75–1.18) H: OR, 0.89 (0.72–1.11) A: OR, 0.92 (0.71–1.19) HMO AA: OR, 0.60 (0.42–0.82) H: OR, 0.78 (0.56–1.07) A: OR, 0.73 (0.49–1.08) Medicaid AA: OR, 0.82 (0.50–1.35) H: OR, 1.19 (0.79–1.81) A: OR, 1.03 (0.60–1.76) Medicare AA: OR, 0.71 (0.58–0.86) H: OR, 1.01 (0.83–1.22) A: OR, 0.85 (0.64–1.15) No insurance AA: OR, 0.40 (0.18–0.88) H: OR, 0.90 (0.53–1.53) A: OR, 0.68 (0.36–1.29)	Private insurance AA: OR, 0.80 (0.61–1.04) H: OR, 1.09 (0.88–1.36) A: OR, 0.99 (0.75–1.29) HMO AA: OR, 0.65 (0.48–0.89) H: OR, 0.90 (0.66–1.22) A: OR, 1.16 (0.80–1.68) Medicaid AA: OR, 0.50 (0.33–0.77) H: OR, 0.80 (0.59–1.09) A: OR, 1.22 (0.85–1.77) Medicare AA: OR, 0.59 (0.49–0.72) H: OR, 0.79 (0.67–0.94) A: OR, 0.82 (0.62–1.08) No insurance AA: OR, 0.33 (0.15–0.71) H: OR, 0.93 (0.61–1.42) A: OR, 1.15 (0.69–1.90)		Yes	Yes	Yes	No
Giacomini (26),1996	W, AA, H, A	All patients discharged from CA hospitals, 1989–1990	A: OR, 0.77 (0.68–0.87)	AA: OR, 0.50 (0.45–0.56) H: OR, 0.58 (0.45–0.64) A: OR, 0.92 (0.80–1.06)	AA: OR, 0.41 (0.36–0.48) H: OR, 0.67 (0.60–0.74)		Yes	Yes	No	Yes
Gittelsohn et al. (27),1991	W, AA	All patients discharged from MD hospitals, 1985–1987		OR, 0.52	Men: OR, 0.45		No	No	No	No

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Gregory et al. (28),1999	W, AA	Patients discharged with AMI in NJ (MIDAS), 1993–1994	Patients <65 y: OR, 0.74 (0.61–0.90) Patients ≥65 y: OR, 0.68 (0.56–0.83)			Patients <65 y: OR, 0.63 (0.52–0.76) Patients ≥65 y: OR, 0.69 (0.54–0.86) Patients <65 y with angiography: OR, 0.67 (0.54–0.84) Patients ≥65 y with angiography: OR, 0.82 (0.61–1.12)	No	Yes	No	Yes
Escarce et al. (29),1993	W, AA	5% sample of Medicare inpatients, 1986	Overall: RR, 0.51 (0.46–0.56) Patients with stress tests: RR, 0.68 (0.58–0.81) Patients with angiography: NA	Overall: RR, 0.32 (0.23–0.45) Patients with stress tests: RR, 0.53 (0.32–0.86) Patients with angiography: RR, 0.68 (0.46–0.98)	Overall: RR, 0.27 (0.22–0.33) Patients with stress tests: RR, 0.36 (0.24–0.53) Patients with angiography: RR, 0.50 (0.40–0.62)		Yes	Yes	No	No
Franks et al. (30), 1993	W, AA	Medicare inpatients with AMI, 1988	Men: OR, 0.50 (0.48–0.56) Women: OR, 0.67 (0.63–0.71)			Men: OR, 0.56 (0.50–0.63) Women: OR, 0.59 (0.50–0.63)	Yes	No	No	No
Goldberg et al. (31),1992	W, AA	Medicare patients receiving CABG, 1986			OR, 0.28		No	Yes	Yes	No
Gornick et al. (32), 1996	W, AA	Medicare patients, 1993		OR, 0.51	OR, 0.43		No	Yes	No	No
Udvarhelyi et al. (33), 1992	W, AA	Medicare inpatients with AMI in 1987, and a random sample of patients without AMI	RR, 0.72	RR, 0.52 Patients with angiography: RR, 0.71 (0.64–0.78)	RR, 0.50 Patients with angiography: RR, 0.68 (0.63–0.74)		Yes	Yes	Yes	No
McBean et al. (34), 1994	W, AA	Medicare patients, 1986–1990		OR, 0.50–0.65	OR, 0.46–0.60		No	Yes	No	No
Ayanian et al. (35),1993	W, AA	Inpatients with Medicare who had angiography and received a diagnosis of CHD, 1987		OR, 0.64 (0.53–0.77)	OR, 0.64 (0.56–0.75)	OR, 0.56 (0.49–0.64)	Yes	Yes	Yes	Yes
Gatsonis et al. (36), 1995	Nonblack AA	Medicare inpatients discharged with a diagnosis of new AMI, 1987§	Low: 0.41 (0.30–0.54) High: 0.94 (0.55–1.29)				Yes	Yes	No	Yes
Gillum (37), 1987	W, AA	NHDS patients, 1981	OR, 0.46		OR, 0.28		No	No	No	No
Ford et al. (38), 1989	W, AA	NHDS patients, 1979–1984	Men: OR, 0.53 Women: OR, 0.81		Men: OR, 0.35 Women: OR, 0.48		No	No	Yes	No
Giles et al. (39), 1995	W, AA	NHDS inpatients with AMI, 1988–1990‖	AA men: OR, 0.67 (0.51–0.87) White women: OR, 0.72 (0.63–0.83) AA women: OR, 0.50 (0.37–0.68)	AA men: OR, 0.68 (0.45–1.02) White women: OR, 0.94 (0.77–1.14) AA women: OR, 0.42 (0.23–0.76)	AA men: OR, 0.63 (0.44–0.90) White women: OR, 0.65 (0.54–0.78) AA women: OR, 0.37 (0.22–0.62)		Yes	Yes	Yes	No
Gillum et al. (40), 1997	W, AA	NHDS patients, 1980–1993	1980: OR, 0.42 1993: OR, 0.91	1993: OR, 0.57	1980–1985: OR, 0.23 1986: OR, 0.38 1993: OR, 0.43		No	No	No	No
Peterson et al. (41), 1994	W, AA	Patients discharged with AMI, 1988–1990	OR, 0.67 (0.62–0.72)	OR, 0.58 (0.48–0.66)	OR, 0.46 (0.40–0.53)	OR, 0.46 (0.41–0.52)	Yes	No	Yes	Yes

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				Patients with angiography: OR, 0.59 (0.51–0.69)	Patients with angiography: OR, 0.69 (0.58–0.82)					
Mirvis et al. (42), 1994	W, AA	VA inpatients with CAD or VHD, fiscal year 1991	OR, 0.75 (0.70–0.81) Patients with VHD: OR, 0.56 (0.40–0.80)		Surgery: OR, 0.65 (0.59–0.72) Patients with VHD: OR, 0.67 (0.46–0.98)		Yes	No	Yes	Yes
Whittle et al. (43), 1993	W, AA	VA patients discharged with primary diagnosis of CVD or chest pain, 1987–1991	OR, 0.72 (0.70–0.75)	OR, 0.67 (0.61–0.72)	OR, 0.45 (0.42–0.48)		Yes	Yes	No	Yes
Mickelson et al. (44), 1997	W, AA, H	Inpatients at a VA medical center who had AMI, 1993–1995	AA: OR, 0.59 (0.35–1.02) H: OR, 0.76 (0.35–1.67)				Yes	No	No	No
Mirvis and Graney (45), 1999	W, AA	VA inpatients with CAD, fiscal year 1994	OR, 0.63 (0.59–0.68)	OR, 0.67 (0.59–0.76)	OR, 0.50 (0.44–0.56)		Yes	No	Yes	Yes
Ness and Aronow (46), 1999	W, AA, H, A	All outpatients seen in 8 months in 1 geriatrics practice, 1998				AA: OR, 0.14 (0.07–0.31) AA/H: OR, 0.24 (0.09–0.23)	Yes	No	No	No
Mirvis and Graney (47), 1998	W, AA	VA inpatients with CAD, fiscal year 1994¶	W vs. AA: OR, 1.86 vs. 1.92	W vs. AA: OR, 1.31 vs. 1.78**	W vs. AA: OR, 1.14 vs. 1.48**		Yes	No	Yes	Yes
Clinical studies										
Maynard et al. (10), 1986	W, AA	Patients in the CASS registry with ≥1 significantly diseased vessel on angiography and CCS class I, 1974–1979			OR, 0.60 (0.45–0.79) CABG recommended: OR, 0.44 (0.26–0.74)		Yes	No	No	No
Weitzman et al. (48), 1997	W, AA	Patients with AMI hospitalized in four states (NC, MD, MS, MN), 1987–1991	Teaching hospital: OR, 0.60 (0.40–1.0) Nonteaching hospital: OR, 0.70 (0.50–1.1)	Teaching hospital: OR, 0.40 (0.20–0.60) Nonteaching hospital: OR, 0.50 (0.30–0.70)	Teaching hospital: OR, 0.40 (0.20–0.90) Nonteaching hospital: OR, 0.30 (0.20–0.60)		Yes	No	Yes	Yes
Maynard et al. (49), 1991	W, AA	Patients with AMI admitted to CCUs in 19 area hospitals in Seattle, WA (MITI registry), 1988–1990	Differences NS; data not provided	OR, 0.50 (0.28–0.91)	OR, 0.39 (0.16–0.93)		Yes	No	No	No
Maynard et al. (50), 1997	W, AA	Patients with AMI admitted to 19 area hospitals in Seattle, WA (MITI registry), 1988–1994	OR, 0.85 (0.70–1.04)	OR, 0.63 (0.49–0.81)	OR, 0.54 (0.37–0.79)	OR, 0.60 (0.45–0.81)	Yes	Yes	No	No
Bearden et al. (51), 1994	W, AA	Outpatients with incident CHD (SHEP cohort), 1985–1991				OR, 0.95 (0.37–2.50)	Yes	No	No	No
Oka et al. (52), 1996	W, H	Patients discharged with diagnosis of AMI (Stanford 5-City Project), 1986–1992	H: NS (data not given)			H: OR, 0.45 (0.27–0.76)	Yes	No	No	No
Ramsey et al. (53), 1997	W, H	Patients with AMI in the Corpus Christi Heart Project, 1988–1990	H: OR, 0.75	Patients with CC H: OR, 0.65 (0.43–0.99)	Patients with CC H: OR, 0.99 (0.59–1.65)		Yes	No	No	No
Stone et al. (54), 1996	Nonblack, AA	Hospital patients with unstable angina or non–Q-wave MI (TIMI-II registry), 1990–1993	RR, 0.65 (0.58–0.72)			RR, 0.44 (0.37–0.52)	Yes	No	No	No
Johnson et al. (55), 1993	W, AA	Multicenter Chest Pain Study, 1983–1986	OR, 0.86 (0.64–1.20)		OR, 0.24 (0.08–0.71)		Yes	Yes	No	No

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Canto et al. (56), 1998	W, H, A	Nonblack patients in National Registry of MI2, 1994–1996	H: OR, 0.94 (0.82–1.08) A: OR, 0.98 (0.82–1.16)	H: OR, 0.95 (0.83–1.10) A: OR, 0.82 (0.64–1.04)	H: OR, 0.97 (0.82–1.16) A: OR, 1.23 (0.96–1.57)		Yes	Yes	Yes	Yes
Scirica et al. (57), 1999	W, nonwhite	Patients with unstable angina admitted to 35 hospitals (GUARANTEE registry), 1996	Appropriate patients: OR, 0.50	Appropriate patients: OR, 0.92	Appropriate patients: OR, 1.13		Yes	Yes	No	No
Taylor et al. (58), 1998	W, AA	Patients in National Registry of MI2, 1994–1996	Nonwhite: OR, 0.85 (0.77–0.95)	Primary, nonwhite: OR, 0.96 (0.84–1.10) Elective, nonwhite: OR, 0.87 (0.78–0.96)	Nonwhite: OR, 0.66 (0.58–0.75)		Yes	Yes	No	No
Conigliaro et al. (59), 2000	W, AA	Angiography patients in 6 VA hospitals with discharge diagnosis of MI, unstable angina, 1989–1995		Equivocal: OR, 0.30 (0.14–0.63) Necessary: OR, 0.34 (0.09–1.31) CABG necessary: OR, 0.95 (0.29–3.10) CABG or PTCA necessary: OR, 4.50 (0.91–22.29) Neither necessary: OR, 1.33 (0.44–4.03)	Appropriate, necessary: OR, 0.44 (0.23–0.86) CABG necessary: OR, 0.42 (0.20–0.86) CABG or PTCA necessary: OR, 2.26 (0.42–12.11) Neither necessary: OR, 0.67 (0.84–5.35)		Yes	No	No	Yes
Hannan et al. (60), 1999	W, AA, H	Race- and sex-stratified sample of patients in sample of hospitals in NY State who had angiography, 1994–1996				AA: OR, 0.64 (0.47–0.87) H: OR, 0.60 (0.43–0.84)	Yes	Yes	No	Yes
Laouri et al. (61), 1997	W, AA, H	Patients with angiography who met RAND criteria for necessary revascularization at 6 LA hospitals, 1990–1991		AA: OR, 0.20 (0.06–0.72) H: OR, 0.62 (0.19–2.00)	AA: OR, 0.49 (0.23–0.99) H: OR, 1.41 (0.78–2.54) A: OR, 0.97 (0.50–1.88)		Yes	No	Yes	Yes
Leape et al. (62), 1999	W, AA, H	Stratified random sample of patients at 13 hospitals in NYC with angiography who met RAND criteria for necessary revascularization, 1992				All hospitals Had procedure AA: OR, 1.05§ H: OR, 0.75 Procedure recommended AA: OR, 1.08 H: OR, 0.76 Off-site hospitals Had procedure AA: OR, 1.98 H: OR, 0.50 Procedure recommended AA: OR, 4.13†† H: OR, 1.05	Yes	Yes	Yes	Yes
Peterson et al. (63), 1997	W, AA	Patients at Duke University Medical Center, Durham, NC, who had angiography, March 1984–December 1992		OR, 0.87 (0.73–1.03)	OR, 0.68 (0.56–0.82)	OR, 0.65 (0.56–0.76)	Yes	Yes	Yes	No

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Sedlis et al. (64), 1997	W, AA	VA patients at 1 medical center who had angiography and were potential candidates for CABG or PTCA, 1988–1996		PTCA recommended: OR, 0.90 (0.66–1.23) PTCA declined: OR, 0.83 (0.10–7.01)	Surgery recommended: OR, 0.59 (0.46–0.75) Surgery declined: OR, 2.51 (1.61–3.90)	Procedure recommended: OR, 0.67 (0.52–0.86) Procedure declined: OR, 2.03 (1.32–3.11)	Yes	No	No	No
Taylor et al. (65), 1997	W, AA	Patients in military health services system who had AMI, 1993	OR, 0.84 (0.57–1.25) Counseled for future CC, nonwhite: OR, 0.56 (0.34–0.84)			OR, 0.90 (0.53–1.54)	Yes	Yes	No	No
Daumit et al. (66), 1999	W, AA	Random sample of patients with ESRD, 1986 and 1987	RR, 0.71 (0.56–0.90)	RR, 0.48 (0.26–0.85)	RR, 0.56 (0.32–0.98)	Any revascularization: RR, 0.55 (0.35–0.84) Any procedure: RR, 0.71 (0.56–0.88)	Yes	Yes	No	No
Oberman and Cutter (67), 1984	W, AA	Consecutive patients with angiography or CABG at UAB, 1970–1978	OR, 0.002 (0.001–0.002)		Patients with 3-vessel disease: OR, 0.26 (0.19–0.35)		Yes	No	No	No
Ferguson et al. (68), 1997	W, AA	Inpatients at 1 VA medical center discharged with diagnosis of CVD or chest pain, 1993	OR, 0.37 (0.24–0.58)	OR, 0.60 (0.25–1.49)	OR, 0.22 (0.08–0.63)	OR, 0.32 (0.21–0.50)	Yes	Yes	No	No
Brook et al. (69), 1990	W, AA	Medicare beneficiaries undergoing angiography, 1981	Nonwhite: OR, 1.02 (0.87–1.15)				Yes	Yes	Yes	No
Carlisle et al. (70), 1999	W, AA, H, A	Patients at 5 LA, CA area EDs with new-onset chest pain‡‡	AA: OR, 0.53 (0.24–1.21) H: OR, 0.63 (0.24–1.64) A: OR, 2.41 (0.30–19.26)				Yes	Yes	No	Yes
Laouri et al. (71), 1997	W, AA, H, A	Patients with positive stress tests in 4 teaching hospitals who met RAND necessity criteria for necessary angiography, 1990–1991	AA: OR, 1.05 (0.54–2.06) H: OR, 1.07 (0.58–1.96) A: OR, 1.01 (0.45–2.25)				Yes	No	Yes	Yes
Nakamura et al. (72), 1999	W, AA, A	Patients admitted to a CCU with MI or unstable angina		AA: OR, 1.01 (0.71–1.45) A: OR, 0.95 (0.62–1.44)			Yes	No	No	No
Ferguson et al. (73),1998	W, AA	Patients at 1 VA medical center with CVD or chest pain, 1993	Received CC: OR, 0.23 (0.12–0.46) Offered CC: OR, 0.35 (0.19–0.64) Refused CC: OR, 6.32 (0.96–41.5) Not offered CC: OR, 7.88 (4.18–14.83) Inappropriate CC: OR, 0.71 (0.07–7.04)				Yes	No	No	No
Barnhart et al. (74), 2000	W, AA, H	Patients at 1 medical center who had angiography, 1990–1993				AA: OR, 0.67 (0.17–2.71) H: OR, 0.39 (0.17–0.92)	Yes	No	No	Yes

* A = Asian; AA = African American; AMI = acute myocardial infarction; CA = California; CABG = coronary artery bypass grafting; CAD = coronary artery disease; CASS = Coronary Artery Surgery Study and Treatment Evaluation; CC = coronary catheterization; CCS = Canadian Cardiovascular Society Classification; CCU = cardiac care unit; CHD = coronary heart disease; CVD = cardiovascular disease; ED = emergency department; ESRD = end-stage renal disease; GUARANTEE = Global Unstable Angina Registry; H = Hispanic; IHD = ischemic heart disease; LA = Los Angeles; MA = Massachusetts; MD = Maryland; MI = myocardial infarction; MIDAS = Myocardial

Infarction Data Acquisition System; MITI = Myocardial Infarction Triage and Intervention Registry; MN = Minnesota; MS = Mississippi; NC = North Carolina; NHDS = National Hospital Discharge Survey; NJ = New Jersey; NS = not significant; NY = New York; NYC = New York City; OR = odds ratio; PTCA = percutaneous transluminal coronary angioplasty; RR = relative risk; SHEP = Systolic Hypertension in the Elderly Program; TIMI = Thrombolysis in Myocardial Infarction; UAB = University of Alabama at Birmingham; VA = Veterans Affairs; VHD = valvular heart disease; W = white; WA = Washington.

† Where not specified, ORs are for African-American persons compared with white persons. Data in parentheses are 95% CIs unless otherwise specified. If the study did not provide ORs and 95% CIs, they were calculated from study data whenever possible.

‡ Sociodemographic factors were always assessed; health-related beliefs and attitudes, patient–physician relationships, and physicians were never assessed.

§ Data represent 50 states.

‖ All groups were compared with white men.

¶ Odds ratios indicate odds after adjustment for procedure availability.

** According to *t*-tests, the odds of having the procedure were greater if the patient lived near a facility with a cardiac surgery program.

†† $P = 0.02$.

‡‡ Odds ratios show the odds of not being tested among patients with an indication for testing.

less likely to receive coronary angiography but not PTCA or CABG (25). One study found that Hispanic persons were less likely to receive any revascularization (46), but another detected no such differences in catheterization, possibly because of a small sample (44).

Authors often controlled for possible sources of variability in use of cardiac procedures (**Figure**), such as sociodemographic factors (24, 37, 41–45, 47, 76). However, even with such adjustments, African-American persons generally remained disproportionately less likely to receive each of the cardiac procedures. To control for organizational and reimbursement or financing factors (such as type of facility or insurance coverage, respectively), studies were conducted in several types of health care systems (for example, Veterans Affairs facilities [41–45], in nonfederal community facilities [21, 27, 35]), among patients with varying insurance coverage (25), among Medicare enrollees (29–36), and among patients who were veterans (41–45, 47). However, procedure use still varied.

When other factors related to the health care system's organization of services, such as the volume of procedures at a particular facility (24), hospital size or ownership (37), or the on-site availability of invasive for cardiac procedures, were controlled for (21, 24, 26, 28, 30, 35, 36, 39, 48), racial disparities in procedure use persisted. Furthermore, the differential effect on African-American persons was greater when local facilities did not offer on-site cardiac procedures (47). Because the supply of "gatekeeper" cardiologists in a community may also influence procedure use, some analyses were limited to patients who received angiography and who by definition had access to a cardiologist. However, racial differences in use of revascularization persisted (35, 39). All of the administrative database studies found at least some statistically significant racial differences between African-American and white persons in use of coronary angiography, PTCA, and CABG. Although less frequently studied, Asian and Hispanic patients also received disproportionately fewer procedures than white persons.

The administrative database studies have several important limitations. First, they lack detailed clinical information about the severity of coronary artery disease for each patient and the clinical appropriateness of the procedures studied. Population rates of procedure use without sufficient clinical information about individual patients' needs for care do not provide adequate information about health care quality. Second, such studies were conducted only on patients who had race data available. Although some administrative data on race is of good quality (77), investigators using data from the National Hospital Discharge Survey found that up to 13% of patients were missing a racial designation (37, 38). Kressin and colleagues (78) found that 46% of Veterans Affairs outpatients were missing data on race, although inpatient administrative files are less likely to be missing such information (for example, in 1999, 3.9% of persons in the Veterans Affairs Patient Treatment File were of unknown race). The potential for bias caused by differential missing data remains a concern. Third, administrative data do not provide information on refusal of procedures, patient preferences, or physician attitudes about specific patients' need for care.

Clinical Data Studies

Eleven of 28 studies that used clinical data drew on existing clinical databases from clinical trials or registries (10, 49–58). The remaining 17 studies collected new data. Some studies tried to control for clinical status by selecting only patients from a narrowly defined disease group. Studies included patients whose angiograms indicated significant coronary artery disease (10, 59–64),

those who were hospitalized with acute myocardial infarction (48–50, 52, 53, 56, 58, 61, 65), those with unstable angina or non–Q-wave myocardial infarction (54, 57), or those with end-stage renal disease and coronary artery disease (66). The focus on a disease group ensures that the clinical indications for procedures are relatively constant among a cohort and minimizes the possibility that members of certain racial groups have less severe disease and therefore warrant less treatment.

Of the 28 studies, 17 found that the odds ratios for receiving some procedures were lower for African-American patients than for white patients. After authors controlled for disease severity, the odds ratios were between 0.03 (67) and 0.85 (58) for catheterization, between 0.20 (61) and 0.87 (58, 63) for PTCA, and between 0.22 (68) and 0.68 (63) for CABG among African-American patients. The persistence of such differences suggests that clinical indications do not completely explain racial differences in procedure rates.

We found eight completely negative clinical studies (51, 56, 62, 65, 69–72) and 14 other studies that detected no differences among some of the procedures. Leape and colleagues (62) found no racial differences in revascularization rates. However, they included only patients who had had angiography in a relatively small number of hospitals in one geographic area, all of which offered on-site angiography and most of which offered on-site PTCA and CABG. The choice of sample and setting may have minimized the study's ability to detect any differences in use. Taylor and associates (65), Bearden and colleagues (51), and Brook and coworkers (69) found no racial differences in procedure use, but the power of each of these studies was limited. Several authors found no differences in catheterization rates (49, 50, 52, 69–71), possibly because of low statistical power. Only a small percentage of the patients in three studies (49, 50, 69) were African American, and three other studies (52, 70, 71) had small samples. Another study found differences in catheterization rates but determined that they were caused by overuse of the procedure in white persons, not underuse in African-American persons (73). Two studies found no differences in PTCA use (56, 72) but could not control for clinical need for the procedure because they lacked angiographic data. The remaining studies, including some with negative findings, had several limitations, such as small samples (52, 71, 79), a small proportion of African-American patients (50, 51), or a small number of procedures (48, 53, 55, 56, 59, 64, 68). One study that found no racial differences in PTCA use focused on primary PTCA only (58).

Ten of the clinical studies included Hispanic or Asian patients. Hispanic patients were disproportionately less likely than white patients to receive PTCA (53), CABG (60), recommendations for revascularization (74), or any revascularization (52). Seven studies, however, detected no differences between Hispanic and white patients in catheterization (52, 56, 70, 71), PTCA (56, 61), CABG (53, 56, 61), or any revascularization (62). In the four studies that included Asian persons, Asian and white patients did not differ in use of cardiac catheterization (56, 70, 71), PTCA (56, 72), or CABG (56). However, the socioeconomic and sociodemographic gap is smaller between white persons and Hispanic or Asian persons than between white persons and African-American persons (80). In addition, some studies may have had low statistical power to detect such differences (52, 53, 61, 70, 71) or may have lacked sociodemographic or financial control variables (53, 72). Although all studies had some clinical data, the amount and type varied. Two studies detected no differences in procedure rates but had only limited data on cardiac disease severity (56, 72).

Clinical studies have considered many other relevant factors, in addition to detailed controls for disease severity. The effect of reimbursement and financing factors, such as amount or type of health insurance coverage, varied by study. In some studies, more insurance coverage led to less racial disparity in procedure use (61, 66), while other studies found that insurance coverage had no effects (62, 63). These disparate findings suggest the need for further research in this area.

Other studies examined patient sociodemographic characteristics, including education, marital status, and employment status. Married patients were more likely to receive procedures in one study (68), but although sociodemographic characteristics were assessed in other studies, their direct association with procedure use was not reported (10, 50, 66, 67).

Many clinical studies have incorporated data on organization of services, including such hospital characteristics as size (56), ownership (61, 62, 71), or teaching status (48). Access to cardiologic subspecialty care has also been controlled for (63), but racial differences in

procedure use have persisted. Finally, although some clinical studies controlled for the availability of on-site cardiac procedures (25, 48, 56, 59–62, 71, 74), racial differences in procedure use remained.

Clinical studies of individual patients have controlled for patient characteristics, including clinical indications and sociodemographic factors, variables related to the organization of health care services, and availability of cardiac procedure technology. Despite these controls, racial disparities in health care use have persisted. Are these disparities clinically meaningful? Peterson and colleagues (63) found that African-American persons were 32% less likely to have bypass surgery, which translated into lower adjusted rates of survival over 5 years (20% among African-American patients vs. 27% among white patients; $P < 0.001$). Of note, among the clinical studies that examined CABG, the odds ratios in the study by Peterson and colleagues were closest to 1.0. This suggests that findings from other studies have even greater clinical implications.

Hypothesis-Driven Survey Studies and Qualitative Research

Clinical studies about racial differences in the use of cardiac procedures accomplished an important goal by using clinical and sociodemographic data to control for patient characteristics. However, several other factors may explain the remaining observed racial differences. Several survey studies have examined hypotheses that emerged from previous research. We reviewed the totality of such studies and the hypotheses they address, further classifying the research according to hypotheses.

Patient Preferences for Invasive Cardiac Procedures

One study reported that African-American patients receiving cardiac care were less likely to recall physicians' recommending exercise tests and coronary angiography. Among those who recalled such recommendations, recollections of adherence did not differ according to race. Recollection of recommendations for cardiac procedures was correlated with patients' knowledge of having cardiac disease. This knowledge varied by sex and race; compared with white men, African-American men less frequently reported knowledge of cardiac disease, although African-American women more often reported knowledge of cardiac disease than did white women (81).

African-American patients were less willing to undergo revascularization than white patients. However, familiarity with the procedure was a stronger predictor of hypothetical willingness than race (82).

Five studies examined medical records or queried physicians about patient refusals as a possible source of variation in procedure use (60, 61, 64, 73, 83). Three studies concluded that patient refusals were infrequent and did not account for disparities (60, 61, 83), while two studies found the opposite (64, 73). However, medical records may not provide complete information. Patients may not overtly decline further diagnosis and treatment but may fail to return for follow-up visits or recommended procedures. Therefore, medical records may not adequately document patient refusals.

Physician Attitudes and Recommendations

Additional survey studies addressed whether physician attitudes about patients and recommendations for invasive cardiac procedures differ according to race. One study found that during oral case presentations, housestaff were more likely to mention the race of African-American patients, even when it was not medically relevant, and were more likely to attribute unflattering characteristics to such patients (84). Several authors have shown that physicians use information about patients' ethnicity, age, lifestyle, and social structure to make decisions about cardiac and other treatments (19, 85, 86). Two studies showed that African-American patients who had significant coronary artery disease on cardiac catheterization were offered revascularization disproportionately less often than white patients (10, 64).

In an experimental study of physician bias in decision making about cardiac treatment, physicians were shown videotapes of patients in which race and age were systematically varied. When the authors controlled for age and clinical status, they found that African-American women with positive results on stress tests were referred for catheterization 13% less often than white men (risk ratio, 0.87) (87, 88). They also found that physicians' assessments of patients' personal characteristics (for example, being a poor or good communicator) differed according to the patients' race and sex. Another recent study found that physicians perceived intelligence, likelihood of risk behavior, and adherence to medical advice differently in African-American patients

who had undergone angiography than in white patients. Physicians also reported feeling less affiliation with African-American patients (89). These results suggest that physician attitudes are important in decision making about invasive cardiac procedures.

Patient Perceptions of the Medical Interaction

Recent qualitative studies have also revealed several issues important to patients. These include the influence of family, friends, or others who had the same type of procedures or might offer advice; the way physicians conveyed information; and the extent to which patients felt their physicians were honest and caring. African-American patients identified several additional issues: concerns that physicians did not know them (90), concerns about health care discrimination and whether physician behavior built or lessened rapport, and belief in one's destiny being ordained by God (90, 91). These findings suggest new hypotheses that must be tested in future empirical work.

Survey results and qualitative research show that patient and physician attitudes and beliefs are important determinants of the use of invasive cardiac procedures. However, because of the small number of survey studies conducted, the predominant absence of controls for disease severity, the failure to restrict study samples to patients who need cardiac procedures, and the inclusion of some but not other pertinent variables in each study, definitive conclusions about the relative roles of patient- or physician-based sources of variation could not be reached.

PRESCRIPTION FOR FUTURE WORK

Before the Initiative to Eliminate Racial and Ethnic Disparities in Health can succeed, the genesis of racial disparities in health care utilization must be understood. Without understanding the true impact and relative importance of the putative factors discussed above, we cannot design effective interventions to eliminate such disparities. Future studies should comprehensively and simultaneously examine the full range of variables relevant to racial differences in the provision of invasive cardiac procedures. On the basis of our review of the evidence, we propose that future comprehensive studies include variables from the patient (including psychosocial, sociodemographic, and clinical variables), the physician (including clinical assessments and attitudes and beliefs about specific patients), and the health care system itself (including availability of services). Furthermore, because previous findings show racial differences in cardiac catheterization rates, future studies should seek to identify factors that affect decision making earlier in the diagnostic process, such as at the point of exercise stress testing or nuclear imaging studies.

CONCLUSION

Most of the literature about racial variations in cardiac procedures has shown that African-American patients receive disproportionately fewer cardiac catheterizations, PTCAs, and CABGs than white patients, even after researchers control for clinical indications. Studies have also found that Hispanic patients and, to a lesser extent, Asian patients are disproportionately less likely than white patients to receive such procedures, although these differences are less consistent.

Findings from future comprehensive studies of racial differences in decision making about cardiac treatment will provide valuable information on the extent and sources of racial differences. With this information, necessary interventions can be designed to address racial disparities in care, thereby decreasing inequities and providing models for similar interventions in other areas of medicine. Although more research on the reasons for racial differences in procedure use is clearly needed, several promising avenues can reduce racial disparities. Improving providers' cultural competence (92) and communication skills (93) and increasing the number of African-American physicians and other clinicians (94) will probably improve relations between physicians and minority patients and may increase patient satisfaction and improve health outcomes. By recognizing racial and ethnic disparity in health care as a quality issue (95), we will improve our ability to monitor and decrease it, allowing us to move toward meeting the goals of the Initiative.

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